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AUTHOR Jones, John Paul; Aaron, Ira E.
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ABSTRACT

In order to determine if significant relationships exist amcng intersensory transfer ability, intersensory perceptual shifting ability, modal preference, and reading achievement, a study was conducted using 90 randomly selected Oconee County, Georgia, third graders whose mean IQ was 98 and whose mean reading comprehension was grade 3. Experimenter-devised tests were administered to all subjects to measure intersensory transfer, intersensory perceptual reaction time, modal preference, and sight vocabulary. In addition, subjects were given the reading subtest of the Metropolitan Achievement Tests, Elementary Battery, Form B and the Lorge-Thorndike Intelligence Test, Level 2, Form A. Positive correlations were found between sight vocabulary and reading comprehension, between intersensory transfer and intelligence, in addition to the expected high relationships among sight vocabulary, reading comprehension, and IQ. It was concluded that (1) auditory-visual integration is related to reading achievement in grade 3, (2) ability to respond rapidly to cross-modal stimulus presentation is related to the sight vocabulary aspect of reading achievement, and (3) direction of modal preference has no effect on intersensory tests used in determining modal preference. Tables and references are included. (MS)

Determining Relationships of Sensory Integrative Skills to the Reading Process*

John Paul Jones
Fort Valley State College

Ira E. Aaron
University of Georgia

Previous investigations involving intersensory transfer, intersensory perceptual shifting, and modal preference have shown significant relationships between these areas individually and various aspects of reading achievement. The interrelations among these abilities warrant further investigation. The purpose of this study was to determine if significant relationships exist among intersensory transfer ability, intersensory perceptual shifting ability, modal preference, and reading achievement at the third grade level with and without the effects of intelligence controlled.

Sample

The sample was composed of 90 randomly chosen third grade subjects from the Oconee County Elementary School in Oconee County, Georgia. The mean IQ for the sample was 98 and the mean grade equivalent for reading comprehension was 3.4, with an actual grade placement of 3.6.

Measuring Instruments

Test of Intersensory Transfer

This instrument is a modified version of the test employed by Birch & Belmont (1964; 1965) to determine auditory-visual integration

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ability. Birch and Belmont's test consisted of three examples and ten test items. The examiner tapped the auditory-temporal patterns on a table top with a pencil. The subject chose the corresponding visual-spatial pattern from among three patterns on a response sheet.

The instrument employed in this study was extended to 20 test items to increase its reliability. The auditory-temporal patterns were presented by tape to insure the absence of visual cues, such as observance of the examiner tapping the patterns on a table top with a pencil. Presentation by tape also served as a control for pattern variations due to human error.

In addition to the above modifications, the test was administered in a group setting rather than individually. All of the visual-spatial patterns were typed on a single response sheet 14 inches in length.

Reliability for the test was computed using the Spearman-Brown Prophesy Formula. A reliability coefficient of .88 was obtained for 51 third grade subjects selected from the same population base as the sample. This reliability coefficient compares favorably with the test-retest reliability coefficient (.85 for third graders) reported by Kahn (1965) and Kahn & Birch (1968) for an individually administered, lengthened (also to 20 items) version of Birch and Belmont's test.

Intersensory Perceptual Reaction Time Test

A bimodal reaction time apparatus was designed and constructed for measuring the speed with which attention can be shifted from stimuli emanating in one mode to stimuli presented in another mode.

The apparatus performs the same basic functions as the apparatus described by Sutton et al. (1961). The examiner can present a series of visual and auditory stimuli to which the subject responds by rapidly removing his finger from a telegraph key. The visual stimuli consist of a red and a green lamp and the auditory stimuli consist of a sonalert and a buzzer. A chronoscope graduated in one-hundredths of a second provides the actual measurement of reaction time. Two persons are required to operate the apparatus--one to give the instructions and present the stimuli, the other to record the reaction time and reset the chronoscope.

In this study, the examiner was interested only in the speed with which a subject could respond to a stimuli presented in a mode different from the mode of the stimulus which preceded it. Therefore only one auditory stimulus and one visual stimulus were used--the buzzer and the red lamp.

A short demonstration and four practice trials were given to each subject. The test consisted of 59 trials. Each trial was completed in approximately three seconds, with a range of two to four seconds. The test, including instructions and practice trials, required approximately four minutes to administer to each subject.

The subject was seated in front of the apparatus and familiarized with the two stimuli. He was instructed to remove his finger from the telegraph key as soon as a stimulus was presented. He was informed that the stimulus terminated with his response and a new stimulus could not be presented until he depressed the telegraph key again. Reaction was measured from the onset of a stimulus

(triggered by the examiner) until the subject responded. The stimuli were presented in an order which appeared to be random. An equal number of shifts to the auditory stimulus and shifts to the visual stimulus occurred in the stimulus program.

The effect of the switch from one modal type stimulus presentation to another modal type was determined by subtracting the mean time for reaction to stimuli preceded by a different modal type. In other words, ipsimodal reaction time was subtracted from intermodal reaction time. Six of the 90 subjects had a faster ipsimodal than intermodal mean reaction time. A constant of 7.78 was added to the difference score of all subjects prior to the data analysis to eliminate the negative sign for the scores of these six subjects.

Test of Modal Preference

The test of modal preference in this study is an individually administered measure of differential performance in learning auditory and visual labels for pictures of concrete objects. The pictures of concrete objects were of a pony, a duck, a rooster, and a calf. The auditory lables consisted of the phonemic representations of four consonant-vowel-consonant nonsense syllables with low associational value (13 percent) selected from a list compiled by Glace (in Hilgard, 1951, p. 544). The syllables were BEP, NAH, WUG, and YOT. The visual labels were graphemic representations of the nonsense syllables used in the auditory task. McKee's (1948, p. 24) false alphabet served as the source of printed symbols. The criterion for completion of each of the learning tasks was two consecutive perfect trials or a maximum of 20 trials with or without two

consecutive perfect trials. The degree of preference for learning auditory or visual labels for pictures of concrete objects was determined by subtracting the visual labeling score from the auditory labeling score for each child. This procedure provided the degree of preference as well as the direction--auditory or visual.

Sight Vocabulary Test

The sight vocabulary possessed by the subjects was chosen as one important aspect of reading achievement. The 60 items for the sight vocabulary test used in this study were selected randomly from the vocabulary lists provided in the basal texts of the teacher's edition of the Scott, Foresman New Basic Readers (1965). This series was the one presently in use in the system from which the sample was chosen. An equal number of words was selected from the first, second, and third reading instructional levels. Inflected, derived, or compounded forms were not included in the selection. Each word was typed on a three by five index card using a primary typewriter.

The subject was seated at a table across from the examiner. An obstacle prevented the subject from seeing either the record sheet or the stack of index cards. The examiner presented the index card for viewing by the subject for approximately one second. The subject was given a reasonable time to respond--approximately ten seconds--before the next word was presented. The ceiling item was the sixth word missed in sequence. The score was the number of words presented minus the number of incorrect responses and no responses.

The test was patterned after the sight vocabulary test employed in a study by Blake, Aaron, & Westbrook (1967). These

investigators reported a reliability coefficient of .95. The reliability coefficient provided by the Spearman-Brown Prophesy Formula for the sight vocabulary test used in the present study was .98.

Reading Comprehension

The Reading subtest of the Metropolitan Achievement Tests, Elementary Battery, Form B, was used as the measure of reading comprehension and administered as a part of the entire Metropolitan Achievement Tests. The battery was given to all third grade pupils in the system by a team supervised by the investigators. The classroom teachers assisted members of the team in distributing and collecting the test booklets and pencils and in maintaining a natural classroom setting.

Intelligence Test

The Lorge-Thorndike Intelligence Test, Level 2, Form A, was used as the measure of intelligence. This test was chosen because: (a) it is a group test of intelligence; (b) it does not require reading ability as a prerequisite for taking the test; and (c) it allows the administrator to move the subjects along from item to item, thus providing greater control of the testing situation.

Procedure

All of the tests were administered between the dates February 26, 1970 and March 24, 1970. All makeups were given within two school days after each initial test administration at times convenient to the examiner and the subjects who missed the tests. The relationships among the variables were determined through computation

of zero-order correlations and partial correlations, with the effects of intelligence controlled.

Findings

As shown in Table 1, the usual high relationships were found to exist among sight vocabulary, reading comprehension, and IQ. All of these coefficients were significant at the .001 level.

The perceptual task which demonstrated the strongest relationships with sight vocabulary and reading comprehension proved to be the modified version of Birch and Belmont's test of intersensory transfer. Both coefficients were found to be significant at the .001 level. Intersensory transfer also correlated significantly ($p < .001$) with intelligence. None of the correlations between intersensory transfer and the other perceptual tasks were significant.

Length of time required to respond to cross-modal stimuli presented in the intersensory perceptual reaction test and size of sight vocabulary yielded a significant ($p < .05$) negative correlation, indicating that subjects with lower mean reaction times to cross-modal stimuli tended to possess a larger sight vocabulary. Intersensory perceptual reaction did not correlate significantly with any of the other variables.

The modal preference scores--obtained by subtracting the scores on the visual labeling test from the scores on the auditory labeling test--did not correlate significantly with the scores provided by any of the tests.

The relationship between extent of sight vocabulary and reading comprehension retained its significance ($p < .001$) with the effects

TABLE 1

Zero-Order Correlations

	IT	IS	MP	SV	RC	IQ
Intersensory Transfer	-----	-.1736	-.1688	.4415**	.3842**	.4583**
Intersensory Shifting		-----	-.1159	-.2358*	-.1910	-.0955
Modal Preference			-----	-.0935	-.0028	.0603
Sight Vocabulary				-----	.7735**	.5725**
Reading Comprehension					-----	.6029**
Intelligence Quotient						-----

* Significant at .05 level

** Significant at .001 level

TABLE 2

Partial Correlations

	IT	IS	MP	SV	RC
Intersensory Transfer	-----	-.1467	-.2214*	.2458*	.1522
Intersensory Shifting		-----	-.1180	-.2219*	-.1677
Modal Preference			-----	-.1564	-.0492
Sight Vocabulary				-----	.6548**
Reading Comprehension					-----

* Significant at .05 level

** Significant at .001 level

of intelligence controlled. Intersensory transfer ability remained a significant ($p < .05$) predictor of sight vocabulary but not of reading comprehension. The correlation between intersensory perceptual shifting and sight vocabulary continued to be significant ($p < .05$).

A significant ($p < .05$) partial correlation was also obtained between intersensory transfer and modal preference. Before the effects of intelligence were controlled, the relationship between these two variables was not significant. The variables were negatively correlated, indicating that subjects preferring the visual mode tended to perform with a higher degree of accuracy on the test of auditory-visual transfer when the effects of intelligence were controlled.

Conclusions

In this section, the findings will be discussed with regard to the findings of previous research and conclusions will be drawn based on these findings.

Intersensory Transfer and Reading Achievement

Intersensory transfer, as employed in this investigation, refers to the association of analogous information received through the auditory and visual channels. The ability to effect intersensory transfer was measured by the modified Birch and Belmont test which requires subjects to match auditory-temporal patterns with visual-spatial patterns.

Muehl & Kremenak (1966) found intersensory transfer ability to be significantly related to reading achievement in grade one;

Birch & Belmont (1965), in grades one and two; Kahn (1965) and Kahn & Birch (1968), in grades two through six for comprehension and three through six for word knowledge; Beery (1967), from ages 8 to 13; Rudnick et al. (1967), in grade three; and Birch & Belmont (1964), Sterritt & Rudnick (1966), and Ford (1967), in grade four. Sterritt et al. (1969) did not obtain a significant predictive value from intersensory transfer for reading achievement for third grade subjects over a seven to nine month period.

Previous research findings concerning the relationship between cross-modal transfer skill and intelligence have been conflicting. Birch & Belmont (1964; 1965) failed to control adequately for the influence of intelligence in their studies, though concluding that intelligence and intermodal transfer ability were both independent predictors of ability to read. Findings reported by Ford (1967) opposed this conclusion. Evidence supporting the conclusion was furnished by Sterritt & Rudnick (1966), Rudnick et al. (1967), Muehl & Kremenak (1966), and Beery (1967). Kahn (1965) and Kahn & Birch (1968) found that word knowledge and intersensory transfer were still highly correlated with intelligence controlled, but that the comprehension and transfer coefficients tended to lose their significance.

In this study, intersensory transfer and reading achievement--sight vocabulary and reading comprehension--were found to be significantly ($p < .001$) related. When the effects of intelligence were controlled, the relationship between intersensory transfer and reading comprehension lost its significance. However, the correlation between intersensory transfer and sight vocabulary retained its significance ($p < .05$).

Kahn (1965) experienced a similar pattern in her investigation using 350 subjects in grades two through six. When the effects of intelligence were held constant, her correlations among intersensory transfer and reading comprehension tended to lose their significance while the correlations among intersensory transfer and word knowledge retained their significance.

The significant ($p < .001$) correlation between intersensory transfer and intelligence and the influence of the effects of intellogence on the relationship between intersensory transfer and reading comprehension indicates that the tests of intersensory transfer and intelligence measure--at least in part--somewhat the same abilities. However, the relationship between intersensory transfer and reading comprehension cannot be entirely attributed to intelligence unless intersensory transfer ability is accepted as a basic part of intelligence. In particular, the Lorge-Thorndike Intelligence Test requires and measures to some degree intersensory transfer or integration of the auditory and visual modes, as can be shown from an examination of the administration procedures.

Performance on the modified version of Birch and Belmont's test of auditory-visual integration and performance on the measures of sight vocabulary and reading comprehension yielded significant correlations, which supports the majority of the research conducted in this area. On the basis of the findings and the corroboration of previous research, the conclusion is drawn that auditory-visual integration is significantly related to achievement in reading in grade three.

Intersensory Perceptual Shifting and Reading Achievement

Intersensory perceptual shifting involves the ability to transfer attention rapidly from one modal source of input to another--

in this study, auditory and visual. Reaction times to these stimuli were measured using a bimodal reaction time apparatus especially designed and constructed for this study. The actual effect of the switch from one modal type of stimulus input to another was established as the difference in mean reaction times to stimuli preceded by same and different modal stimulus types.

Raab et al. (1960) found that poor readers in the fourth and fifth grades demonstrated significantly greater difficulty than good readers in reaction time to shifts in modal source of stimulus input. In a very similar study, Katz & Deutsch (1963) found significant differences in response time to cross-modal shifts between good and poor readers for Negro boys in the first, third, and fifth grades. However, in a study reported by both Hurd (1967) and Busby & Hurd (1968), a significant relationship was not found to exist between speed of cross-modal perceptual shifting and reading achievement. Hurd concluded that the difference in findings between his study and Raab et al. (1960) and Katz & Deutsch (1963) might be attributed to the difference in experimental design, since he used a random sample rather than extreme groups.

In the present investigation, the effect of intersensory perceptual shifting on reaction time was found to be inversely related to size of sight vocabulary. Subjects whose reaction times were affected the least by unexpected shifts in mode of stimulus presentation tended to have the larger sight vocabularies. The significance ($p < .05$) of this relationship was relatively unaffected when the effects of intelligence were controlled. The relationship

between intersensory perceptual shifting and reading comprehension was not significant with or without the effects of intelligence considered. The only conclusion which can be drawn concerning intersensory perceptual shifting and reading achievement is that ability to respond rapidly to cross-modal stimulus presentations is significantly related to size of sight vocabulary which is considered an essential aspect of reading achievement.

Modal Preference and Reading Achievement

Previous investigations involving modal preference and reading achievement which are most pertinent to the present study include those by Budoff & Quinlan (1964), Cripe (1966), Robinson (1968), and Bruininks (1968). None of these investigations demonstrated that modal preference was significantly related to reading achievement.

In this study, modal preference was viewed as that mode--auditory or visual--most preferred by an individual as indicated by task performance. Auditory and visual labeling tasks were constructed which required the subjects to learn strange auditory labels (using nonsense syllables) and strange visual labels (using a false alphabet) for pictures of concrete objects. The direction and extent of modal preference was obtained by subtracting the score on the visual task from the score on the auditory task.

The measure of modal preference did not correlate significantly with either reading comprehension or sight vocabulary. One possible explanation is the evidenced low ceilings of the auditory and visual labeling tasks. Perfect scores were recorded by 25

percent of the subjects on the auditory labeling test and 22 percent on the visual labeling test, indicating that the tests were too easy for major portions of the subjects.

Intersensory Transfer, Intersensory Perceptual Shifting, and Modal Preference

Though not significantly related to each other, both intersensory transfer and intersensory perceptual shifting were significant predictors of sight vocabulary, with and without the effects of intelligence controlled. Intersensory transfer correlated significantly ($p < .001$) with intelligence; intersensory shifting did not. Based on these findings, the conclusion is drawn that the tests of intersensory transfer and intersensory perceptual shifting do not measure the same skills.

Modal preference did not correlate significantly with either intersensory transfer or intersensory shifting using zero-order correlation. However, with the effects of intelligence held constant, the relationship between modal preference and intersensory transfer became significant ($p < .05$). The relationship was negative, indicating that subjects who expressed a preference for the visual mode on the visual and auditory labeling tasks tended to perform the intersensory transfer task with greater success. However, this relationship achieved significance only through the relationships of the two variables with intelligence. Therefore, the conclusion is drawn that the direction of modal preference has no significant effect on intersensory tests used in determining modal preference.

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